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The American Association of Zoo Keepers, Inc. exists to advance excellence in the animal keeping profession, foster effective communication beneficial to animal care, support deserving conservation projects, and promote the preservation of our natural resources and animal life.

ABOUT THE COVER

This month's cover photo features a Cheetah (*Acinonyx jubatus*) by Dane Jorgensen of Omaha's Henry Doorly Zoo. The cheetah is the world's fastest land animal. They can run 70 mph (or 110 kph), which is as fast as cars drive on the highway. The cheetah can reach its top speed in just three seconds. The cheetah has a long, muscular tail that has a flat shape. The tail almost functions like a rudder on a boat because they use it to help control their steering and keep their balance when running very fast.

The cheetah has "semi non-retractable" claws that work like the cleats on a football shoe to give the cheetah a lot of traction when running. The pads of most cats' paws are soft, but the cheetah's pads are hard like the rubber on a tire. This also helps them grip the ground when they are running so fast. Cheetahs have "tear marks" that run from the inside corners of their eyes down to the outside edges of their mouth. These marks help reflect the glare of the sun when they are hunting during the day. These marks also work like the sights on a rifle, to help the cheetah "aim" and stay focused on their prey when they are hunting. There are less than 8,000 cheetahs left in the wild, making the cheetah Africa's most endangered big cat. To learn more about cheetahs, go to the Cheetah Conservation Fund's site at cheetah.org. When you participate in Bowling for Rhinos, you also directly support one of BFR's beneficiaries, Action for Cheetahs in Kenya. To learn more go to: actionforcheetahs.org/

Articles sent to ***Animal Keepers' Forum*** will be reviewed by the editorial staff for publication. Articles of a research or technical nature will be submitted to one or more of the zoo professionals who serve as referees for ***AKF***. No commitment is made to the author, but an effort will be made to publish articles as soon as possible. Lengthy articles may be separated into monthly installments at the discretion of the Editor. The Editor reserves the right to edit material without consultation unless approval is requested in writing by the author. Materials submitted will not be returned unless accompanied by a stamped, self-addressed, appropriately-sized envelope. Telephone, fax or e-mail contributions of late-breaking news or last-minute insertions are accepted as space allows. Phone (330) 483-1104; FAX (330) 483-1444; e-mail is shane.good@aazk.org. If you have questions about submission guidelines, please contact the Editor. Submission guidelines are also found at: aazk.org/akf-submission-guidelines/.

Deadline for each regular issue is the 3rd of the preceding month. Dedicated issues may have separate deadline dates and will be noted by the Editor.

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FROM THE BOARD OF DIRECTORS

The AAZK Recognition Team recognizes outstanding achievements and financially supports conservation efforts and professional development of the AAZK membership.

As we settle in to the New Year, I would like to recognize the AAZK Committee Chairs and Vice Chairs, the AAZK Program Managers and Vice Managers, and all of the Committee and Program Members for their dedication to AAZK. Their time and effort are a very important part of our success as the premier professional organization for zoo keepers and aquarists. I strongly encourage each of you to consider getting involved with AAZK on the National level when opportunities arise.

I am serving my third year on the Board of Directors and am currently the Board Oversight for the AAZK Recognition Team. The AAZK Recognition Team is comprised of the Awards and Grants Committees. The AAZK Recognition Team recognizes outstanding achievements and financially supports conservation efforts and professional development of the AAZK membership.

I believe that many of you will agree that we did not enter this career for the paycheck, however recognition from one's peers is priceless. Is there someone in your Chapter or at your Institution that you feel should be recognized for their accomplishments? Please take a moment to look around your organization for a worthy nominee for one of the many grants or awards offered by AAZK. You can nominate someone for a specific outstanding achievement or the culmination of a career-long accomplishment.

The following are the awards currently presented by AAZK (descriptions and nomination forms can be found on the Awards Committee page of the AAZK website http://aazk.org/committee/awards-committee/):

- Lifetime Achievement – AAZK Professional Service Award
- Lifetime Achievement – Meritorious Service Award
- Lee Houts Advancement in Enrichment (LHAE) Award
- Excellence in Zoo Keeper Education Award
- Excellence in Exhibit Renovation Award
- Excellence in Animal Nutrition Award
- Jean M. Hromadka Excellence in Animal Care Award
- Lutz Ruhe Meritorious Achievement – AAZK Professional of the Year Award
- Nico van Strien Leadership in Conservation Award
- Barbara Manspeaker AAZK Chapter of the Year Award

The deadline for all Award nominations is May 1, 2018.

The AAZK Grants Committee offers members the opportunity to acquire "FREE MONEY". Well, not exactly 'free', but if you are selected for a grant, they come with a monetary component to provide financial assistance for conservation projects, professional development and non-invasive research. The following are the Grants currently offered by AAZK (descriptions and nomination forms can be found on the Grants Committee page of the AAZK website http://aazk.org/committee/grants-committee/):

- AAZK Professional Development Grant – Deadline March 1, 2018
- AAZK Conference Professional Development Grant – Deadline March 1, 2018
- AAZK Conservation, Preservation and Restoration Grant – Deadline March 1, 2018
- AAZK Research Grant – Deadline March 1, 2018
- AAZK – Trees for You and Me Grant for Reforestation – Deadline May 1, 2018
- AAZK – Bowling for Rhinos Conservation Resource Grant – Deadline June 1, 2018
- International Outreach Committee – AAZK Conference Latin America Travel Grant – Deadline January 1, 2019

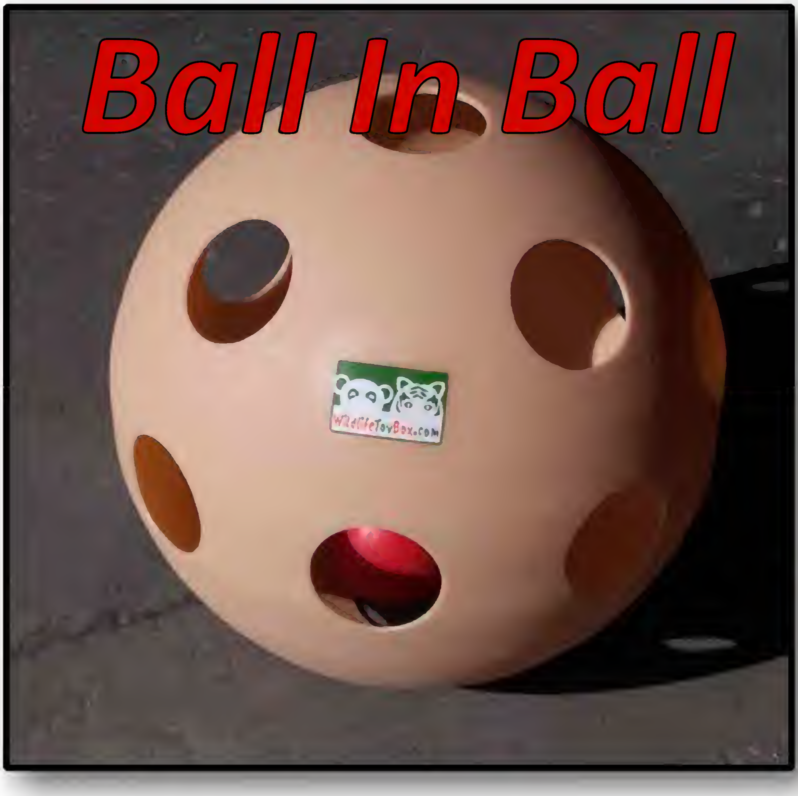
Please note, unlike Awards, the Grants have many different deadlines.
For more information, please visit the Awards and Grants Committees pages of the AAZK website at www.aazk.org. We look forward to hearing from you.

With thanks and appreciation,

Bill Steele

Bill Steele
AAZK Board of Directors
Bill.Steele@aazk.org

Ball In Ball



The **Ball in Ball** comes in a standard 18” diameter ball with a 4” inner ball. Custom orders are always accepted, we have manufactured the **Ball in Ball** in a 36” diameter. These fun toys start in Light Duty and finish at Severe Heavy Duty, with 33 color options. An animal toy with holes is a challenging and entertaining way to keep your zoo animals active. Don’t overlook the fact that they can also be used as feeders.

Order a Ball In Ball during the month of February, use coupon code 564 when ordering through our Wildlife Toy Box website and receive 5% OFF the item price.

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COMING EVENTS

Post upcoming events here!
e-mail shane.good@aazk.org

March 24-29, 2018
AZA Mid-Year Meeting
Jacksonville, FL
Hosted by Jacksonville Zoo and Gardens
For more information go to:
aza.org/conferences-meetings#mym

April 8-13, 2018
Animal Behavior Management Alliance (ABMA) Annual Conference
San Antonio, TX
Hosted by San Antonio Zoo and Sea World San Antonio
For more information go to:
theabma.org/abma-annual-conference/

April 10 or 11, 2018
(*same workshop held each day)
Ape Cardio Health Workshop
Waco, TX
Hosted by Cameron Park Zoo
For more information contact:
orangutan@wacotx.gov

May 4-6, 2018
Recon: Reconnecting with Elephants in Restricted Contact.
Colorado Springs, CO
Hosted by
Cheyenne Mountain Zoo
For more information go to:
cmzoo.org/index.php/recon-elephant-workshop/

May 7-11, 2018
Practical Zoo Nutrition Management
Front Royal, VA
Hosted by Smithsonian-Mason School of Conservation and National Zoological Park. Go to:
smconservation.gmu.edu/programs/graduate-and-professional/professional-training-courses/nutrition/

August 23-25, 2018
International Symposium on Pangolin Care and Conservation
Brookfield, IL
Hosted by Chicago Zoological Society
For more information contact:
amy.roberts@czs.org

September 23-27, 2018
AZA Annual Conference
Seattle, WA
Hosted by Seattle Aquarium and Woodland Park Zoo
For more information go to:
aza.org/conferences-meetings#mym

October 14-18, 2018
International Congress on Zookeeping
Buenos Aires, Argentina
Hosted by Fundacion Temaiken and the International Congress of Zookeepers
For more information go to:
iczoo.org/congress

October 15-20, 2018
Otter Keeper Workshop
Portland, OR
Hosted by Oregon Zoo
For more information go to:
otterkeeperworkshop.org/

AMERICAN
ASSOCIATION
of ZOO KEEPERS

October 4-8, 2018
AAZK National Conference
Denver, CO

Hosted by the Rocky Mountain AAZK Chapter and Denver Zoo

rmaazk.org/2018-national-aazk-conference/

October 25-27, 2018
Waterfowl Conservation Workshop
Greenville, NC
Hosted by International Wild Waterfowl Association and Sylvan Heights Bird Park
For more information go to:
waterfowlconservation.org

2018 AAZK AWARDS NOMINATIONS OPENED

The American Association of Zoo Keepers (AAZK) Awards Committee is accepting nominations for the following awards:

- Lifetime Achievement - AAZK Professional Service Award
- Lifetime Achievement - Meritorious Service Award
- Lutz Ruhe Meritorious Achievement - AAZK Professional of the Year Award
- Jean M. Hromadka AAZK Excellence in Animal Care Award
- Nico van Strien Leadership in Conservation Award
- Lee Houts Advancement in Enrichment Award
- Certificate of Merit for Zoo Keeper Education
- Certificate of Excellence in Exhibit Renovation
- AAZK Excellence in Animal Nutrition Award

Awards will be presented at the 2018 AAZK Conference in Denver, CO. The deadline for nominations is 1 May 2018. Information concerning the qualifications, nomination procedure, selection procedure and an explanation of the awards may be obtained at www.aazk.org, under committees/awards.

2017 WAS A BANNER YEAR FOR TREES FOR YOU AND ME!

Thanks to you, we raised $18,364.45 in 2017 for the Trees for You and Me Grant. We would like to congratulate our 2017 grant winners: Lisa Simms, for her project "Cadwalader Park Reforestation," and Dr. Rebecca Swab, for her project "Healthy Forest, Healthy Wildlife." The recipients will each be receiving $9,182.22 to help support their projects. Thank you to all of the AAZK Chapters for participating this year, helping us to further AAZK and Polar Bears International's quest to fight climate change through reforestation and habitat revitalization!

We are looking forward to 2018, and we can't wait to surpass our 2017 total! We invite Chapters to donate during the TREEBLITZ period from February 1 - April 1, 2018. The Chapter that donates the most during this time will be matched by Polar Bears International up to $500! The winning Chapter will also be featured on social media for their generous donation. Chapters can partake through an event or through a single donation to help TFYM support reforestation and habitat revitalization projects worldwide.

Don't know how to start organizing a Trees for You and Me event for 2018? Check out the AAZK TFYM Program page for more information or contact the TFYM Program Manager Christy Mazrimas-Ott at Christy.Mazrimas-Ott@AAZK.org. Be sure to look out for TFYM updates and tips coming to your Chapter's e-mail in 2018!

Thank you for your continued support. Let's keep working to ensure a bright future for our planet!

Sincerely,
The Trees for You and Me Program

Christy Mazrimas-Ott, Program Manager
Anthony Nielsen, Vice Manager
Krista Hyme, Event Coordinator
Tanya White, Communication Liaison
Dawn Fleuchaus, Grant Coordinator
Nicole Pepo, Conference Coordinator

AVAILABLE GRANTS

So you don't have enough funding to cover the conference, research or conservation project you would like to do? Well, look no further! AAZK offers four exciting grants to help you grow in your career as a zoo keeper. Applications and guidelines for each grant can be found on the AAZK website. The deadline for all four grants is March 1, 2018. Start planning now so you won't miss your chance to apply. If you have questions, please contact Jessica Biggins at jessica.munson@aazk.org.

THE AAZK PROFESSIONAL DEVELOPMENT GRANT

The AAZK Professional Development Grant is designed to assist AAZK members with costs associated with attending professional meetings/workshops or participating in field research. There is a total of $2000 for this grant; amount can be divided among applicants. Deadline is March 1, 2018.

Qualifications: Full-time zoo keepers/aquarists in zoological parks and aquariums, who are professional members of AAZK, Inc. in good standing, are eligible to receive grants.

The National AAZK Conference Grant

The AAZK Conference Grant is designed to help with the costs to attend the National Conference. Applications will be accepted for travel to attend a National AAZK Conference. This grant will help with the costs of travel, registration, and hotels. There is a total of $1000 for this grant; the amount can be divided among applicants. **Deadline is March 1, 2018.**

Qualifications: Full-time zoo keepers/aquarists in zoological parks and aquariums, who are professional members of AAZK, Inc. in good standing, are eligible to receive grants.

THE AAZK RESEARCH GRANT

The purpose of the AAZK Research Grant is to encourage and support efforts in non-invasive research conducted by AAZK members in zoological parks and aquariums around the world. There is a total of $2000 for this grant; amount can be divided among applicants. **Deadline is March 1, 2018.**

Qualifications: Full-time zoo keepers/aquarists in zoological parks and aquariums, who are professional members of AAZK, Inc. in good standing, are eligible to receive grants. The primary investigator for the research project must be a professional AAZK member. Researchers other than zoo keepers may participate in the funded studies.

THE AAZK CONSERVATION, PRESERVATION AND RESTORATION GRANT

The purpose of the AAZK CPR Grant is to encourage and support efforts in conservation conducted by AAZK members in zoological parks and aquariums around the world. There is a total of $1000 for this grant; amount can be divided among applicants. **Deadline is March 1, 2018.**

Qualifications: Members of AAZK in good standing are eligible to apply and receive grants. The member must have an active role in the conservation effort submitted for consideration. Due to the nature of conservation projects, the scope of the project or number of people involved will not be restricted.

Did I mention the deadline is March 1, 2018? We look forward to receiving your applications!

Effect of Nocturnal Exhibit Lighting on the Activity of a Springhaas and Potto at the Milwaukee County Zoo

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100 North East Avenue
Waukesha, WI 53186

Abstract

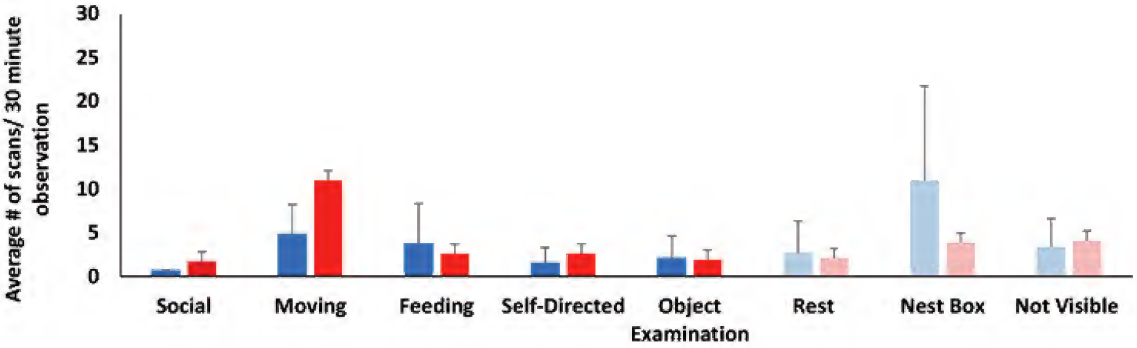
There is growing evidence that the nature of artificial lighting used in nocturnal exhibits may influence animal behavior and welfare. To investigate this relationship, we observed the behaviors of a potto (*Perodicticus potto*) and a springhaas (*Pedetes capensis*) at the Milwaukee County Zoo using focal animal scan sampling under both blue and red light conditions. We found that the potto exhibited significantly more active behaviors and significantly fewer inactive behaviors under red light conditions. The springhaas did not exhibit a significant c in active or inactive behavior when the lighting changed, which may be attributable to the animal's advanced age. Our results are generally consistent with other research that suggests that red lighting may promote more species-typical behavior in captive nocturnal animals.

Introduction

The strategic priorities of the American Zoological Association (AZA) highlight the importance of animal care, health, and welfare while still recognizing the responsibility of zoos to educate the public and conserve species (AZA, 2016). Recently, these efforts have included a rigorous assessment of appropriate lighting in nocturnal exhibits that enhances animal welfare while improving visitors' ability to see the animals (Fuller et al., 2013). According to Fitch-Snyder and Schulze (2001), the lighting guidelines for nocturnal animals, especially primates, are relatively vague, stipulating only that the simulation of "daylight" be created by a minimum of a 75fc light bulb for twelve hours per day, with "moonlight" mimicked using acetate filters. Although these filters may be either blue or red, there are disagreements over which color of lighting is more appropriate. North American zoos that house nocturnal lorisids, a family of nocturnal primates, are split evenly as to whether they house these animals in red spectrum light or blue spectrum light (Fuller et al., 2013). Fuller and colleagues suggested that zoos may use blue light primarily because it more closely approximates moonlight for zoo visitors and thus allows for a more immersive zoo experience. Although the blue lighting may be pleasing to visitors, there has been some research to suggest that blue light may negatively affect animal welfare.

Potto (*Perodicticus potto*). *Photo by Emily Richardson.*

The exhibit under blue light. *Photo by Emily Richardson.*



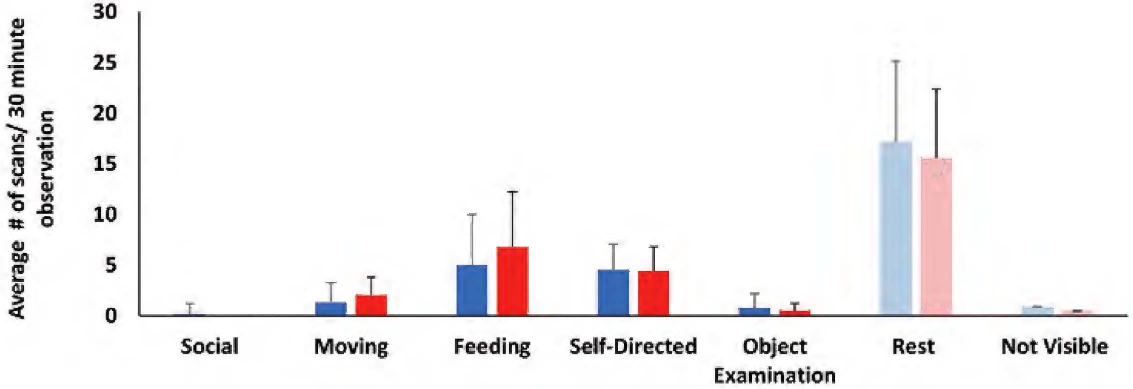
The potto was active during a significantly higher number of scans ($p < 0.001$) and inactive during significantly fewer scans ($p < 0.001$) under red light conditions. The largest changes were the decrease in "nest box" and increase in "moving" under red light. The colors of the bars on the graph represent the light condition in which the subjects were exhibited. The darker bars are active behaviors and the lighter bars are inactive behaviors.

Blue light has repeatedly been implicated in research as a cause of health problems in animals. For example, Prayitno et al. (1997) discovered that broiler chicken chicks reared in blue light walked, stood, and stretched their wings less frequently compared to chicks reared under red light, which appeared to affect the chicks' subsequent health by creating abnormal strides, body weight, bone length, and torso size. Similarly, Bedrosian et al. (2013) found that hamsters exposed to blue light for long periods of time developed changes in the structure of the hippocampus. The hamsters in this experiment also showed signs of reduced activity, which the researchers hypothesized resulted from the altered brain structure.

These and other studies have led zoos to consider changing their exhibit lighting from blue light to red light. The Milwaukee County Zoo, an AZA-accredited institution in Wisconsin, changed their nocturnal exhibits from blue to red lighting in November 2016. To investigate the impact of this change, we observed the behavior of a potto (*Perodictius potto*) and a springhaas (*Pedetes capensis*) that shared a common exhibit in the nocturnal house. We hypothesized that the springhaas and potto would exhibit higher frequencies of active behaviors under red light compared to blue light. The results of this study can help keepers determine whether similar changes would benefit animal welfare at other zoos.

Methods

Our study was conducted at the Milwaukee County Zoo in the small mammal building. The research subjects were one five-year-old, female potto (*Perodictius potto*) and one fifteen-year-old male springhaas (*Pedetes capensis*). Pottos are known to move slowly and silently to avoid predators. These primates also spend a lot of their time foraging (Alterman, 1995). Springhaas in the wild spend much of their time digging tunnels, foraging, and watching for predators (Dieterlen, 2005). They often stay in one area and travel approximately 270-365 meters per day (AWF, 2016). At the zoo, the springhaas and potto cohabitate two exhibit areas that are each approximately 1.8 meters high, 1.8 meters long, and 3 meters wide with a consistently open shift-area dividing the two exhibits. One of the four walls in each exhibit is glass for visitor viewing while the other walls are darkly colored. The flooring is made of gunite and there are various climbing structures including branches, logs, and small mounds. The Milwaukee County Zoo has historically used blue spectrum lighting in all of their nocturnal animal exhibits to closely mimic "natural darkness" while still allowing visitors to see the animals on exhibit. This "night-time" lighting system was created with two fluorescent bulbs covered by blue plastic or black paper in each exhibit. The "day-time" lighting was created with four 40-watt, cool white bulbs. The "day-time" bulbs were on from 8pm to 10am, slowly dimming off completely to just leave the "night-time"



Although the springhaas tended to move more frequently and rest less frequently under red light, the overall differences in activity ($p = 0.193$) and inactivity ($p = 0.199$) were not statistically significant. Colors are represented as in Figure 1.

Springhaas (*Pedetes capensis*). *Photo by Emily Richardson.*

bulbs on. The “night-time” lights were constantly on, even during “day-time” hours.

We recorded baseline behaviors under blue light from September 22 to November 10, 2016. On November 17, the blue light spectrum was switched in the exhibit to a red light spectrum. This red light was created by one 15-watt bulb with a red film on its plastic casing. The “day-time” bulbs were simultaneously switched to four 10-watt, LED cool white bulbs. The dimming from “day-time” to “night-time” stayed the same as it had been in the blue light. We recorded behavior under red light conditions from January 5 to March 9, 2017. A second male potto and one female Moholi bushbaby (*Galago moholi*) were added to the exhibit space on January 8, 2017 during the red light observation period. All animals were given access to an additional exhibit on the same day.

During baseline (blue light) observations, one researcher collected data for two hours on Tuesday afternoons, two researchers collected data for two hours on Thursday afternoons, and one researcher collected data for two hours on Friday mornings. During red light observations, one researcher collected data for two hours on Thursday mornings and the other researcher collected data for two hours on Friday mornings. Each week, we alternated which researcher (ER or JW) observed each animal. A total of 86 hours of data were collected with 43 hours in each lighting condition. We recorded behaviors using focal animal scan sampling, following an ethogram originally created by Fuller et al. (2016; Appendix A). We modified the ethogram to differentiate between inactive behavior (rest, nest box, other, and not visible) and active behaviors (social, moving, feeding, self-directed, and object examination). The focal animal was observed for four 30-minute intervals per day and behaviors were recorded every minute within each interval. Scan sampling was appropriate for studying activity of these two species because they are generally slow moving individuals. Thus, the one-minute intervals and the long observation period allowed us to record a more representative sample of behaviors (WCS and AZA, 2008). We standardized our observations by using operationally defined behaviors (Fuller et al., 2016). We conducted an initial trial data collection on the same animal to agree on what constitutes specific behaviors. After the initial trial, we informally assessed inter-observer reliability every Thursday throughout the fall.

At the conclusion of the study, we compiled the total number of scans in which each behavior was observed during each 30-minute interval. These totals were then averaged for each animal and each lighting condition to generate graphs. We compared the distribution of scans in which active (or inactive) behavior was observed under blue light to that under red light for each animal using a Mann-Whitney U test. An alpha value of 0.05 was used to determine statistical significance.

Results

The potto was active during a significantly higher number of scans ($p < 0.001$) and inactive during significantly fewer scans ($p < 0.001$) under red light conditions (Figure 1). Under red light, the potto’s active behaviors, especially “moving,” increased while her inactive behaviors, especially “nest box,” decreased. Anecdotally, we noticed this increase in activity levels by how much more we had to follow the potto from exhibit to exhibit in red light.

In contrast, the springhaas did not show any significant change in active ($p = 0.193$) or inactive ($p = 0.199$) behaviors between the lighting conditions (Figure 2). Under the red light conditions, the springhaas tended to “move” and “feed” more frequently and “rested” less often, but these differences from blue light were not statistically significant.

Discussion

Fuller et al. (2016) investigated potential differences in the activity levels of animals housed under both blue and red light at two facilities. There were two pottos and one grey bamboo lemur (*Hapalemur aureus*) at one facility and two pottos, one slow loris (*Nycticebus coucang*), one aye-aye (*Daubentonia madagascariensis*), and two bushbabies (*Otolemur crassicaudatus*) at the other. Using an ABA study design, the researchers observed the subjects’ behaviors under both conditions. As with our current study, they found that the animals were more active in red light and were more likely to “rest” or “nest-box” in blue light. Fuller and colleagues recorded “moving” and “object observation” most frequently under red light. Similarly, we found that the potto moved more frequently and spent less time in the nest box under red light. Although our springhaas did not exhibit any significant changes in activity after the light change, his behaviors tended to follow the same trend. It is possible that his advanced age impacted his overall level of activity.

During the light change there was the addition of new “day-time” lights (changing from 34-watt to 10-watt cool white bulbs), two new animals (a male potto and a female Mohol bushbaby), and one more exhibit space. Because of these additional changes during the red light condition, we cannot explicitly state that the behavior changes we observed were due to the red light alone, but we believe that it was a significant factor. These impressions are supported by the observations of the zoo staff, who made the decision to change the lights throughout the nocturnal house based on the preliminary observations of the behavioral changes observed in the potto and, to a lesser extent, in the springhaas.

Anecdotally, we noticed visitors commenting on how it was easier to see the animals and their entire exhibit when it was illuminated in red light. However, there was also some concern that the red light did not look as natural as the blue light previously had. This red light also washed out the colors of the perches and foliage that the keepers had put in the exhibit to mimic the animals’ natural habit.

A suggestion for future research would be to investigate the responses of a wider array of nocturnal species, including those that are not primates, to changes in environmental lighting. Our research showed that a primate species benefitted from the light change, similarly to the research done by Fuller et al. (2016), but because our non-primate subject did not show any significant change, future research could focus on determining if there would be a significant change in the activity of younger non-primate species. Another suggestion for future research would be to investigate health problems or physiological signs of stress correlated with exhibit lighting (Prayitno et al., 1997; Bedrosian et al., 2013). Minimally-invasive measurements of concentrations of melatonin or cortisol could indicate changes in sleep cycles or stress levels of the animals.

Our research complements that of Fuller et al. (2016), to suggest that at least some species exhibit more positive and species-typical behaviors when housed under red light conditions. We recommend that future research focus on investigating a wider array of nocturnal species. In addition, research on non-zoo species suggests that there would also be value in assessing hormonal evidence of stress by looking at melatonin or cortisol levels. Ultimately, because zoos want their animals to exhibit as many natural behaviors as possible (AZA, 2016), the significant change in activity levels of the potto under red light suggest that red lights in nocturnal exhibits may be beneficial for animal welfare.

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The exhibit under red light. *Photo by Emily Richardson.*

Appendix A

Ethogram of behaviors recorded in this study, adapted from Fuller et al. (2016).

Behavior	Operant Definition
Social	Allogrooming, social exploration, social play, reproductive behaviors, or agonistic behavior
Move	Motion in any direction, including climbing and backing up
Feed	Ingesting food, normally by grabbing a food item with one hand and taking it to mouth. Includes drinking from surface or dipping hands in liquid and licking the hand
Self-Directed	Auto-grooming using toothcomb or tongue, self-scratching using grooming claw or nails, facial rubbing (rubbing snout, chin, cheeks, or neck on a substrate or object), or rubbing the head against the arms
Object Examination	Animal is physically manipulating an object using hands or teeth or is actively sniffing an object
Rest	Animal is motionless and is lying down, sitting, or assuming the sleeping ball posture. The animal's eyes may be open or closed. The animal may be actively scanning the environment
Nest Box	The animal is not visible for an extended period of time (more than one minute) and inspection of the exhibit suggests it is resting in the nest box or another hiding location
Other	The animal is exhibiting any other behavior than those defined above
Not Visible	The animal or its behavior is not visible because it has briefly gone out of sight but has NOT retreated to the nest box

Management Strategies and Introductions of Two Lion Litters at the Columbus Zoo and Aquarium

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Background

In 2015 The Columbus Zoo and Aquarium was housing 1.2 lions for breeding purposes. The females, Asali and Kazi, were 10 and 9-years-old, respectively. The tightly-bonded females are half-sisters and had been together for nine years. The 12-year-old male, Tomo, was housed alone prior to being introduced to the females in 2008. In September of 2009, The Columbus Zoo welcomed four cubs born to Asali and Tomo. In 2015, the zoo celebrated two more cubs fathered by Tomo and Kazi. Asali gave birth to 1.3 on August 16, and Kazi gave birth to 2.0 on August 20.

Asali gave birth on exhibit with Tomo and Kazi present. Tomo and Kazi stayed with Asali and her four cubs overnight. The next morning, the plan was to try to shift all lions inside, which would hopefully include the cubs. Asali, however, amended our plans—she did not bring the cubs inside until Day 11. Tomo and Kazi had remained inside away from Asali during that time. Kazi and Tomo had also been separated inside due to Kazi's impending delivery.

Kazi's delivery, on the other hand, went as planned, inside the building and in her respective den room. Kazi had actually shown signs of an impending labor one day prior to delivering. Her demeanor was a huge indicator for keeper staff. On August 19 she decided to move to the den box and became very territorial over it, wanting to be by herself through the process and keeper staff abided and vacated the building only coming in when absolutely necessary and monitored her on the cameras until after the cubs were born.

Pride Introductions

The pride introductions started almost immediately after Kazi and Asali gave birth. Knowing a prolonged separation could cause strife between the adults and cubs, our goal was to put all nine lions back together as quickly and safely as possible. Thirteen days after Asali's cubs were born and nine days after Kazi's cubs were born the process for pride introductions began. The introductions and howdies started in a nonconventional way. Instead of working to get the lionesses back together right away, we worked on individually reuniting them with Tomo. We did this for a couple reasons: 1) Asali and her cubs had just moved to an indoor den and we wanted to give all of the lions time to adjust. 2) The females were exhibiting territorial and protective behaviors toward each other and due to our building design, the females'

upper floor dens or 'territories' were directly across from each other with one pen as a buffer. Each had visual access to the other unless we locked Asali out of the buffer pen. It was not until August 30 (14 days after Asali's cubs were born and 10 days after Kazi's cubs were born) that Kazi began to tolerate Asali's presence. Until this time Kazi wouldn't let Asali enter the buffer pen. Keepers would open the door for Asali and Kazi would leave her den with her cubs and charge the mesh, growling and spitting at her. Asali would never enter the buffer pen because of it. On August 30 Kazi would still leave the den when keepers opened the door for Asali, but she would lay up on her bench and watch Asali. Her posture and positioning was still very rigid and she would emit low grumbles, but she allowed her to enter it. Gradually Kazi allowed Asali to wander further into the buffer pen and for longer periods of time. It wasn't until September 14 (29 days after Asali's cubs were born and 25 days after Kazi's cubs were born) when Kazi began feeling more comfortable and allowed keepers to move onto the next stage of providing the litters with greater visibility to each other.

On August 26 we had our very first howdy and it was between Kazi and Tomo. It started six days after Kazi's cubs were born. We gave Kazi howdy access to Tomo in his pen on the lower floor. The howdy lasted a few seconds–the only contact being a nose-to-nose greeting. After two more howdy sessions, we put Kazi and Tomo together giving them access to three pens. It was an exceptional intro with significant positive displays of rubbing and playing. Intros for Kazi and Tomo started at five minutes and gradually increased over time and space with Kazi's comfort level. At Day 12 of their intro their playtime expanded into their exhibit with access to the building.

Asali's first howdy was 13 days after her cubs were born–it was with Tomo. Their howdy was not as seamless as the one between Kazi and Tomo. Asali showed little interest in Tomo, but Tomo exhibited significant interest in her. The howdy lasted a few seconds but there was no contact despite Tomo's attempts. We did another two howdy sessions before putting Tomo and Asali together. Their first introduction was similar to their howdies–Tomo wanted to play with Asali, but she wanted to go back to her cubs. They did sniff and rub each other, but most of the interaction was initiated by Tomo. On Day 20 of their intro, their playtime expanded into their exhibit with access to the building.

On August 30, the lionesses were shifted to lower level pens away from their cubs for their first howdy session as individuals. Litter howdies were still being done upstairs; however, moving the females for the howdies was done in the hopes of eliminating the overprotective and territorial stance (mainly displayed by Kazi). Over time this had favorable results and was the catalyst for reuniting the pride. Their howdies started at a few minutes and increased based on their comfort levels of being away from the cubs.

On September 3, Asali and Kazi were introduced (18 days after Asali's cubs were born and 14 days after Kazi's were born). As with all of the other howdies and introductions, they were introduced on the lower level in three pens. The introduction lasted one minute and proceeded as anticipated. They immediately attacked each other–the keepers having to separate them. We left them howdied next to each other for 15 minutes until they were both calm and quiet; Kazi even laid down. The females went through the same routine for the next five days. During that time, they appeared to have established territories within the pens. Asali stayed on her side of the three pens and Kazi on hers. The decision was made to take further measures to encourage the necessary positive interactions between the females. Due to the successful individual introductions with Tomo, it was decided to use him to facilitate the interactions with the females. The outdoor yard was chosen for the three adult lion introductions due to increased space as well as a necessary change of setting. We discussed the pros and cons of this decision, mainly how to separate them if it became necessary. Obviously, there are no doors to an open yard. We had to rely on our paint ball guns, hoses, and fire extinguishers. With the end goal of a united pride, we proceeded with our plan and put the three adult lions on exhibit. This introduction was similar to the one inside. The females immediately began fighting. They fought intermittently for several minutes. Eventually, they separated and appeared relatively unharmed. From this point on, the adults were put together every day following the same routine. The adult introduction continued to fluctuate–no two days were the same. Gradually, over the next 22 days, they adapted and learned how to coexist.

On September 14, female and cub howdies upstairs were still ongoing and progressively increasing litter visibility allowing for more interaction opportunities. Cub yard introductions were also being done at this time. Keepers were training cubs to transfer through the chute into the exhibit and showing them their new territory. The goal of keeper participation was to show the cubs their boundaries and barriers (i.e. hot grass, moat, etc.) and to increase keeper/lion bonds. This process continued until all cubs displayed awareness of their boundaries and knowledge of how to return to the building.

On September 27 (42 days after Asali's cubs were born) we started doing howdies between Tomo, Asali, and her four cubs. The initial howdy was relatively uneventful. The female cubs greeted Tomo at the mesh and vice versa. As the howdies continued the cubs interacted more with Tomo through the mesh,

making nose-to-nose contact and vocalizing. The howdy progressed to include Tomo and Asali in significant nose-to-nose contact and positive vocalizations. Both would rub against the mesh vocalizing and occasionally grooming one another through it. Tomo exhibited confident and attentive behavior as he followed Asali's lead.

On September 30 (49 days after Kazi's cubs were born), we started doing howdies between Tomo, Kazi, and her two cubs. During the initial howdy Kazi growled at Tomo once, and kept her cubs away from the mesh. Tomo also stayed away from the mesh. As the howdies continued, Kazi became more comfortable, and she would let her cubs interact with Tomo through the mesh. She was stricter with Tomo than Asali had been, and Tomo would not approach or move until Kazi allowed it.

The litter howdies were still ongoing–there were good days and bad days. Angry charges and fights were still happening through the mesh--all initiated by Kazi. The tension developed to the point where the females had their rigid territories and neither would approach the mesh to interact. The hardest and most time consuming part of our pride introductions was the female introductions and howdies. The time period for the introductions and howdies was August 28 to December 15. During this time, keepers tried various methods to develop positive female interaction as well as to encourage female interest in the other's cubs. The different methods we tried were:

1. Asali and cubs howdy/intro with Kazi
   - Initially this howdy/intro went very well. The cubs immediately interacted with Kazi. Kazi would mildly discipline them, and the cubs would respect her space. She would never initiate the interactions; the cubs would always approach her. Whenever this howdy/intro was done Kazi would pace at a doorway, check other doors, and then pace back at her usual door. You could tell she was uncomfortable, but was being tolerable. Asali would establish authority over the intro without physical contact with Kazi every time this howdy/intro was done. She would hang back in a different room, would even at times lay down and just watch her cubs with Kazi. Her face was stoic and her body relaxed. All you'd occasionally see is her flick her tail or emit a low grumble and the cubs would come back to her. However, as this introduction continued Kazi's mood changed, she became less tolerant of Asali's cubs. She stopped them from approaching her using a low growl. The third introduction Kazi was a bit calmer, but still pacing. One of the female cubs approached her and Kazi snarled. Asali did not react. The next day we did the introduction again and Kazi's mood changed again. She was outwardly aggressive with the cubs. She gave them a few warnings initially that did not seem to register with the cubs. A cub approached and Kazi charged her. Asali didn't react until the keeper did and they were immediately separated. When the keeper stopped Kazi, Asali immediately got up, vocalized to the cubs and moved them into the second farthest pen from her. Due to Kazi's increasing aggression, we no longer tried this method.
2. Kazi and cub howdy/intro with Asali
   - This method was found to be the most successful due to these factors: (1) Asali having had a litter before was much more relaxed and could spend the most time apart from her cubs. (2) Asali let Kazi grow as a mother and gave her space--almost becoming submissive in the beginning. Our only issues with this method were that early on Asali wanted to be with her cubs and would pace at the doors. As the days went on Asali did not want to interact with Kazi, but would interact with her cubs and vice versa. We came to another stalemate with this method because Kazi and Asali still would not interact. We eventually gave them exhibit access to increase space and comfort for Kazi. This approach ended up working in our favor.
3. Asali and cub howdy/intro with Kazi and cubs
   - This method was found to be futile because neither girl would leave the mesh line that their cubs were on. There was no interaction between the girls and it created more anxious and stress behaviors in the females.
4. All adult howdy/intro with all cub howdy (i.e. all adults together in pens while all cubs together on other side of mesh.)
   - This method was attempted because Tomo was doing so well with the introductions. We thought we could use Tomo as a buffer to alleviate the stress between the females. Initially, the howdies worked; however, when all adults were put together, it backfired. Instead of the girls being less stressed, they became more stressed and took out their aggression on Tomo. We stopped using this method.

While those trial and errors were going on Tomo was still being included in the introduction rotation. On October 5 (50 days after Asali's cubs were born and 46 days after

Kazi's cubs were born) Tomo, Asali and her four cubs were introduced inside the building. The introduction could not have gone better. Asali and Tomo greeted and were vocalizing happily. Asali let Tomo greet the cubs and let the cubs interact with him. Asali did her job and corrected Tomo a couple of times to set the rules and Tomo obeyed. As their introductions continued these behavior patterns remained consistent. Asali would discipline Tomo as soon as he was put in with them. Then the six of them would act as a family unit until Asali wanted to take the cubs back up to their pen. As Asali's comfort level with the cubs' roaming increased, we would expand the roaming access. On October 9 they were given access to the exhibit and because it was a change in the routine Asali immediately made sure Tomo still knew his place. She would continue to put him in his place for the next few introductions into the yard. Each session only lasted a few seconds and then when it was over they acted as a family unit. Wherever one went, they all went.

We also introduced Tomo, Kazi, and her two cubs in the building on October 9. This introduction went as well as Tomo and Asali's. Kazi did her job and corrected Tomo a couple of times to set the rules and Tomo again obeyed. In the beginning, Kazi was much more lenient with Tomo and his interactions with the cubs. She let Tomo discipline them much sooner than Asali did and would let him play rougher with the cubs. After their first introduction, Kazi did not correct him at all. On October 12 this family unit was given access to the exhibit. Their introduction to the yard went as well as all their other milestones.

On November 17 (93 days after Asali's cubs were born and 89 days after Kazi's cubs were born), Kazi's mood changed again. Her introductions with both Asali and Tomo were progressing, however, on this day it appeared she had had enough. During her intro with Tomo she showed aggressive behavior and continued to be aggressive until we separated them. Her introduction with Asali went great, but then the following day she showed aggressive behaviors to both Tomo and Asali during her separate introductions with them. The aggression had been much more severe and longer lasting with Tomo than those with Asali; therefore, we continued the intros with Asali but went back to doing howdies with Tomo, Kazi, and her two cubs. Her howdies with Tomo continued to show her very aggressive behavior toward him. On November 20, Kazi was fine during their adult playtime, but during her howdy with Tomo she continued displaying aggression. Tomo would lay down in the farthest part of the adjacent pen away from Kazi staring at the wall with his back to her until she was moved. By November 29 we were able to reintroduce Tomo, Kazi, and her two cubs. She still was not at ease with Tomo, but she was allowing him to be in her vicinity without going after him.

By early December the introduction with Asali, Kazi, and Kazi's two cubs was at its best. The girls were greeting each other and Asali was starting to clean and play with Kazi's cubs. Kazi was also doing much better with Tomo. They were interacting, but Tomo was still uncomfortable. The turning point for the girl's relationship was on December 5. Tomo was becoming possessive over Asali and Asali went after him. Kazi joined the conflict in Asali's defense. From that point on, other than the usual lion skirmishes, they were back to the normal, pre-litter dynamics with Asali as the dominant female and Kazi the submissive. We continued with our normal introduction rotation to make sure Kazi was comfortable until December 15. On that day, we added litter introductions to see if our hopes would be confirmed in that Kazi was finally ready to be with Asali's cubs. Although she grumbled a bit with the cubs, she let them jump on her and let Asali run the show. It was a complete game changer.

The next day on December 16 (122 days after Asali's cubs were born, 118 days after Kazi's cubs were born) we put the whole pride together and we did it on exhibit. It was the most terrifying and rewarding day in this process. We chose to do it on exhibit to give Kazi the space she needed so she did not feel trapped by Asali's cubs. We wanted to give her an escape instead of having her feel cornered and lashing out. The introduction went as well as we had hoped, and Asali lived up to every expectation for her dominant role. The moment Kazi and her cubs were put in the yard with Asali, Tomo and the four cubs, Asali put Kazi in her place and Kazi submitted. Although Kazi still grumbled around Asali's cubs, she tolerated their presence. When she became uncomfortable, she avoided them instead of going after them. Before everyone was separated the three adults greeted each other and were content.

The next day followed the same suit. Kazi and her cubs would be added to the introduction, and then Asali would put Kazi in her place. On the third day, Asali did not discipline Kazi. Instead she let her wander the yard. All nine lions eventually went to their sunning spot and laid down as a pride. Kazi would occasionally growl and correct a cub, and Asali would stand up and look at Kazi. Asali finally displayed trust in Kazi. From this point, the two litters were never separated. During that time, Kazi and Asali made amazing strides and rebuilt their relationship. Kazi was fully tolerant of Asali's cubs--even letting them nurse off of her. Kazi was finally displaying her normal, pre-litter behavior.

The whole pride introductions were postponed eight days due to temperatures; however, all prior introductions continued inside the building to maintain relationships. On December 30, whole pride intros resumed. Instead of Asali correcting Kazi, Kazi and Asali started ganging up on Tomo. As of the writing of this article, this is still ongoing.

On January 13 (149 days after Asali's cubs were born, 145 days after Kazi's cubs were born) we started doing overnight howdies with the two litters and Tomo. On January 16, we started putting the whole pride together inside on cold days. On January 19, we started letting the pride be together all day and all night. Our pride was officially a pride again!

Trees For You and Me, and for the Increasingly Rare Species of the Florida Sandhill

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Abstract

The Trees For You and Me (TFYM) grant program was formed in 2009, in partnership with the American Association of Zoo Keepers (AAZK) National and Polar Bears International (PBI), as a tree-planting initiative to offset anthropogenic carbon emissions by planting trees to sequester atmospheric carbon. In 2016, for the first time, the TFYM grant program extended their mission to combat the impacts of climate change by including habitat restoration projects and awarded the Rare Plant Conservation Program of Bok Tower Gardens a grant to restore habitat and conserve rare species in a local state park. Many of Florida's rare species are adapted to specific habitats, but much of the remaining habitat is fragmented, severely degraded and can no longer support a diversity of native species. Restoring critical habitats through fuel reduction, removal of invasive species, prescribed fire, and the reintroduction of native species is imperative to preserving ecosystem functions, conserving wild populations of endangered species, and supporting the multitudes of native plants and animals that rely on these habitats. Through the TFYM grant program, 32 hectares of long-degraded sandhill habitat were restored, replanted with longleaf pines (*Pinus palustris*), turkey oaks (*Quercus laevis*), bluejack oaks (*Quercus incana*), and wiregrass (*Aristida stricta*), and became the permanent, protected home for a new population of nearly 800 clasping warea (*Warea amplexifolia*). In turn, these activities are helping the AAZK and PBI achieve their goals to restore novel ecosystems capable of long-term atmospheric carbon sequestration and long-term forest carbon storage.

Introduction

The gentle rolling landscape of the critically imperiled sandhill ecosystem once covered nearly 29 million hectares across the Southeastern U.S. Coastal Plain, including much of the uplands in north and central Florida (USFWS, 1999). Sandhill is often described as a longleaf pine savanna dominated by a diverse variety of grasses and herbaceous wildflowers. The high open canopy of longleaf pine is widely distributed, allowing sunlight through to the forest floor all year long, a requirement of the diverse groundcover. The midstory is sparse with scattered deciduous oaks and a variety of shrubs providing nectar and pollen for pollinators and fruit for wildlife.

Following early European settlement, entire sandhill forests were clear-cut for agriculture, cattle grazing, and lumber products, and their deep, well-drained sands were ideal for development, roads and railways. The U.S. Fish and Wildlife Service estimates that less than 3% of sandhill exists today (USFWS, 1999), millions of hectares lost forever.

Loss of sandhill has continued as habitat is converted to residential and commercial developments. The remaining sandhill habitat is fragmented, increasingly degraded, with their healthy biodiversity of species giving way to invasive, exotic species and the overgrowth of hardwoods, because of lack of fire. Sandhill is a fire-dependent habitat, adapted to frequent (2-5 year), low intensity, lightning-sparked fires. During the spring and summer months when storms are frequent throughout Florida, lightning would ignite fires in the forests, and fallen pine needles and grasses would quickly carry low-intensity fire for hundreds or even thousands of hectares. Rather than being destructive, regular fire kept the canopy and midstory open by knocking back the hardwoods that would otherwise become overgrown and shade the landscape. Fire suppression leads to a loss of the rich understory of herbaceous plant species, the loss of habitat and food for native wildlife, and transforms sandhill into a dense hardwood hammock that is occupied by invasive, and exotic plant species.

Pristine sandhill habitat can be absolutely stunning. During the fall season, the deciduous turkey oaks begin to succumb to the subtle climatic fall changes and transform from vibrant green to deep reddish brown. The grasses begin to flower, wiregrass filling in the groundcover with tall, champagne-colored wispy flowering stems, and a variety of purple, white, orange and yellow wildflowers peek through the grasses.

A view of the restoration site.

The restoration team at a planting site.

Tree planting at the restoration site.

A tree planting event at the restoration site.

Restored habitats can capture a glimpse of the beauty only the Native Americans and early explorers were graced with the pleasure of witnessing before so much of this habitat was destroyed.

Healthy sandhill has one of the highest levels of species diversity in North America, and according to LandScope America™ "more than 40 species have been documented in a single square meter, and as many as 170 species in 1,000 square meters, or ¼ acre." It is home to pocket gophers (*Geomys pinetis*), northern bobwhite (*Colinus virginianus*), American kestrels (*Falco sparverius*), songbirds such as pine warblers (*Setophaga pinus*), Bachman's sparrows (*Peucaea aestivalis*), and many listed species including the red-cockaded woodpecker (*Picoides borealis*), eastern indigo snake (*Drymarchon couperi)*, Sherman's fox squirrel (*Sciurus niger shermani)*, gopher tortoise (*Gopherus polyphemus)*, and Florida sand skink (*Neoseps reynoldsi)*. Some rare plant species found in sandhill include the giant orchid (*Orthochilus ecristatus*), Florida toothache grass (*Ctenium floridanum*), showy dawnflower (*Stylisma abdita*), scrub pigeon-wings (*Clitoria fragrans*), Lewton's polygala (*Polygala lewtonii*) and clasping warea. When the habitat is fragmented and degraded, all of these species are severely impacted. Gopher tortoises no longer have the open sand gaps they need to forage and build burrows, the ground cover of native grasses and herbaceous species required by northern bobwhite for nesting is lost, and eastern indigo snakes no longer have the home range needed for hunting. The unique genetic material in the remaining populations of endangered species is lost as native species are replaced by invasive and exotic species.

In addition to supporting wildlife with food and shelter, healthy sandhill helps provide other essential ecosystem services including nutrient cycling, filtering waters destined for the headwaters of the Everglades, providing nectar and pollen for the many pollinators we depend on for food production, purifying our air and water resources, and sequestering atmospheric carbon. Conservation of critical habitats and their biodiversity requires the dedication of land managers, conservation biologists and many volunteers working together on multi-year projects to restore habitat and (re)introduce species. Bok Tower Gardens and the Florida Park Service partner to restore habitat and biodiversity within public lands in central Florida. The 2016 TFYM grant made possible a year of sandhill restoration within two parcels in Lake Louisa State Park with invasive species removal, prescribed fire, the introduction of three native tree species and establishing a new population of the endangered clasping warea.

Project overview

Lake Louisa State Park is a 1,769 hectare treasure located south of Clermont in central peninsular Florida. It borders the northeast corner of the Green Swamp, a significant hydrologic resource, and is situated on the northernmost edge of the Lake Wales Ridge, an ancient Florida ridge and a hotspot of rare endemic species. Through much of the early 1900s, the site that is now Lake Louisa State Park was privately owned, its land converted to pasture, used as a cattle ranch, and fire suppressed. Now under state ownership through the Florida Department of Environmental Protection, park managers work hard to restore its natural habitat, much of which was historically sandhill. Lake Louisa itself is the largest lake of a chain of thirteen lakes and an Outstanding Florida Waterway. The location of this park, with all of its surrounding critical resources, makes it even more important for restoration to help protect water resources and create habitat corridors.

Clasping warea (Brassicaceae) is an annual flowering plant in the mustard family that can grow to three feet tall. It is found only within sandhill habitat along the northern third of the Lake Wales Ridge. It requires open sand gaps and canopy gaps, and is both federally and state listed as endangered. Seedlings germinate in the spring, and flowering primarily occurs from August through October. It has pale lavender to purple cleome-like flowers, and the characteristic heart-shaped, pale-green leaves which clasp the stem can be used to identify it when it is not flowering. Fewer than ten populations are thought to exist, most of which are small, on private land, and in severely degraded habitat. Securing a sufficient number of self-sustaining populations on protected, managed lands is one of the recovery objectives outlined by the U.S. Fish and Wildlife Service to prevent extinction of clasping warea (USFWS, 1999).

Although clasping warea had not been historically documented at Lake Louisa State Park, the Park lies within its historically known range, and the remnant sandhill areas contain the appropriate soil series. Clasping warea can be an important component in restoration of the sandhills of central Florida, as observations suggest that it may be used for nectar by a variety of floral visitors, including hover flies, at least two wasp species, native bees and butterflies such as the Zebra swallowtail, *Eurytides marcellus* (Peterson, 2016).

In early 2016, Bok Tower Gardens' Rare Plant Conservation Program staff met with park managers and selected two burn units as priorities for sandhill restoration. A restoration plan was outlined and sites were selected for the introduction of native trees and clasping warea.

Restoration begins…

In late 2016, removal of invasive exotic species and overgrowth of the canopy and understory in the two burn units was initiated using mechanical removal and herbicide application. A prescribed fire was performed in December, and herbicide treatment of tree stumps took place to prevent regrowth. Throughout the rest of 2016 and into

2017, Florida Park Service staff continued assessing site needs, and applied additional herbicide treatments and invasive species removal as needed. The project's sites were greatly improved, and to help reestablish a native sandhill understory, seeds of native groundcover species were sown, including wiregrass and a diversity of flowering herbs and forbs. By June 2017, the site was in good shape and ready for the introduction of clasping warea and native tree seedlings.

Because most of the remaining clasping warea populations are small, declining, and may be genetically depauperate, seeds from three local populations were used to propagate seedlings for the new populations. This strategy was chosen to best preserve this species in the park by establishing the healthiest, genetically diverse, and most self-sustaining populations. From February to June, plants were propagated within the greenhouse at Bok Tower Gardens. Unique number tags were assigned to each plant prior to the introduction day to track genotype survival and reproductive status, and 1.9-cm polyline was extended throughout the selected planting areas for irrigation, with injectors staggered along the lines to provide water to each individual plant. In June, approximately 800 plants were transplanted along the irrigation lines with the help of 18 people including staff and volunteers from Lake Louisa State Park, Bok Tower Gardens, the Florida Native Plant Society and the Florida Fish and Wildlife Conservation Commission's volunteer group called the Ridge Rangers. Park staff irrigated the introduced plants immediately afterwards, then as needed to ensure each plant would get approximately 2.5-cm or more of water every three days for three months from either rainfall or irrigation.

In early fall, a total of 1,130 trees (800 longleaf pines, 200 bluejack oaks, 130 turkey oaks) that had been propagated using locally sourced material, were transplanted in the project areas. The Ridge Rangers helped staff and volunteers from Lake Louisa State Park and Bok Tower Gardens transplant the trees over two days.

Early assessments

Periodic visits to the introduction sites showed that wiregrass and native herbs and forbs are successfully populating the restoration areas. There has been very high survival and good growth of the clasping warea, and many were flowering on schedule. A few pollinators were even observed visiting the plants. The collection of demographic data from the new populations, including size and fecundity, took place in November as part of Bok Tower Gardens' population-level research into clasping warea, and showed that these populations are off to a good start. Survival of the new tree seedlings also looks promising.

Into the future...

As the newly introduced native species gradually replace the invasive species that formerly occupied the site, the more natural and healthy balance of sandhill biodiversity will become firmly established, which can then be sustained by regular prescribed burns. The introduced flowering species, including clasping warea, will gradually spread throughout the restoration site, providing food and nectar to wildlife and building robust seedbanks that will sustain the populations into the future.

The new clasping warea populations will help preserve the genetic diversity of the source populations that could otherwise be lost, and produce seeds that can be used to create new populations in the future. Annual monitoring of the new populations will take place to study seedling recruitment and survival, and track the success of these populations over time. Collecting of a small portion of the seeds from the new populations each year will help determine their reproductive output, and help assess long-term population viability.

As we watch the continued growth and improvement of these restored sites over the years, we can be confident in the many immeasurable benefits made possible. Imperiled sandhill animals and plants are provided much-needed homes and food, and biodiversity is supported. Restored lands are no longer a fire danger to the community, but will safely accommodate wildfires compared to unrestored lands. Ecosystem services such as providing clean air and water are increased, as restored, biodiverse lands are at least 1.5x more productive at generating oxygen, uptaking carbon dioxide, and other ecosystem services than lands with low diversity (Cardinale et al., 2011). Introducing one of the most important components of sandhill, the longleaf pine, into these restoration sites helps ensure the resilience

Longleaf pine.

Turkey oak.

Bluejack oak.

of the ecosystem for centuries. Longleaf pines are long-lived, are resistant to pests and diseases, and are adapted to both seasonally wet and dry periods. They are capable of sequestering carbon for hundreds of years and produce high quality wood products due to their high specific gravity and low rate of decay (Kush et al., 2004). In fact, commercial products from these pines can last for centuries. When longleaf pines were felled long ago, the wood was often transported to local sawmills by placing felled pines in a nearby river and sending downstream, which would sometimes result in pines being sunk to the bottom of the river and lost. The Goodwin Company based in Florida built a successful business recovering these submerged forgotten pines, and using the high quality heartwood to custom-build antique home flooring. The pines used to create this high quality flooring are guaranteed to be at least 200 years old, also guaranteeing that this species can act as a long-term carbon sink for centuries.

Longleaf pines are also better suited to withstand some of the projected adverse effects of global climate change. Seasonal changes in temperatures and precipitation trends associated with global warming are expected to exacerbate the destruction of pine stands by the southern pine beetle. The unique resins found in the longleaf pine are more resistant to damage by infestation of the southern pine beetle than are other southern pine species (NWF, 2009). Storm frequency and intensity is also predicted to increase, putting forests along the southeastern coastal plain at increased risk of devastating impacts. An experimental mixed pine stand established in 1960 in Mississippi, 20 miles north of Gulfport, was assessed for damages following a direct hit from Hurricane Katrina in 2005. This study found that longleaf pines suffered less mortality and damage compared to loblolly (*Pinus taeda*) and slash pines (*Pinus elliottii*) (Johnsen et al., 2009). Longleaf pines have exhibited superior resistance to damages from hurricane force winds, thereby minimizing the negative impacts to healthy, restored sandhill habitats.

This project has been very rewarding and mutually beneficial. It helped support the overall restoration goals for Park managers, and helped Bok Tower Gardens' goals of restoring habitats and conserving rare species. It provided a good model of how different organizations can partner together for a conservation goal, each bringing individual talents and areas of expertise, and provided many outreach opportunities to the public, including hands-on experience for local citizens.

We are looking forward to continuing species preservation efforts in partnership with the FDEP, to build on the efforts under this grant, and witness the biodiversity continue to flourish. Additional burn units have already been selected for future restoration and rare plant introductions within Lake Louisa State Park, to further bring the beauty and benefits of the sandhill to future generations of park visitors.

Bok Tower Gardens is a nonprofit public garden located in Lake Wales, Florida, with a strong conservation mission to fulfill Edward W. Bok's vision to "Make you the world bit better or more beautiful because you have lived in it." Established in 1986, the Rare Plant Conservation Program is an important expression of this vision and works to understand and preserve the rarest plant species of Florida through research, restoration, introductions, propagation, education, rescues, by participating in the Center for Plant Conservation through a curated National Collection of rare plant germplasm, and by organizing the annual state-wide Rare Plant Task Force meeting. The Rare Plant Conservation Program was named the 2011 Regional Recovery Champion by the Southeast region of the U.S. Fish and Wildlife Service, won the 2014 Livable Polk Award for regional conservation efforts, and won the 2017 International Botanic Gardens Conservation International Global Seed Conservation award. For more information, head to www.boktowergardens.org and follow our activities on our Facebook page.

Acknowledgments

Our partners for this project included The Florida Department of Environmental Protection (FDEP). We wish to specifically thank Chris Matson, Scott Spaulding and Aldin Matthews of the FDEP. Thank you also to all of the Ridge Ranger, Florida Native Plant Society, FDEP and Bok Tower Gardens volunteers who assisted with this project.

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TRAINING TALES

COORDINATORS: Jay Pratte, Henry Doorly Zoo • Kim Kezer, Zoo New England • Angela Binney

Forming a Solid Foundation

Nicole Presley, Curator of Mammals
Fresno Chaffee Zoo
Fresno, California

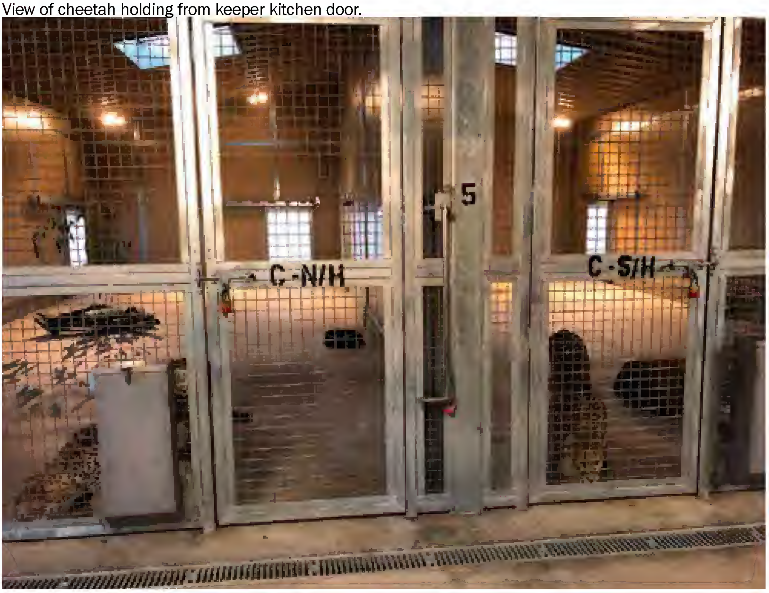
In the great cheetah (*Acinonyx jubatus*) migration of 2017, to accommodate Cheetah SSP breeding recommendations, the Fresno Chaffee Zoo acquired two new females and sent our previous females out to breeding facilities. Our previous cheetahs had arrived with trained behaviors that we modified slightly and expanded upon to accommodate our training program. However, our new arrivals “Trich” and “Jesiri” were young and had no training experience according to the information we had received on their AAZK Animal Data Transfer Form. The African Carnivore team was excited to start working with these girls and shape foundation behaviors.

Keepers enter the cheetah building via a separate kitchen area. Another door opens from the kitchen into the service hallway and when it opens you are face to face with the front mesh of the two large cheetah pens. We lock cheetahs into holding overnight when wind parameters require, but otherwise they have exhibit access overnight. Our previous cheetahs would often need to be recalled in the morning, but Trich and Jesiri are often waiting for us in holding every morning. We offer diet twice a day and most of the time we run training sessions at both feeding opportunities. Meat is prepped into the training pouches in the kitchen and then the keepers approach to start sessions wearing the pouches and feed with tongs through the mesh. We can also feed into the pens via a built-in chute.

Once Trich and Jesiri cleared quarantine, the keepers began training sessions, shaping foundation behaviors like target, sit, down, and up. While in quarantine, they were fed using the chutes. This would now be the first time they would eat from tongs. In fact, because their history indicated that they hadn’t been hand-fed before, we thought that we might have to start training there. However, Trich and Jesiri had no hesitations about coming right up to the mesh to eat. In fact, they were very eager to eat and it was immediately

Jesiri waiting calmly for delivery of reinforcement after “down” behavior.

View of cheetah holding from keeper kitchen door.



Trich performing a "sit" behavior during a morning training session, attentive and mouth closed.

apparent that we had an unwanted behavior developing. Since they were often in the pens waiting for the morning sessions to start, as soon as the trainers opened the door from the kitchen both of them would sit and gnaw on the hard wire mesh in anticipation. The door opening to reveal keepers wearing pouches was a huge cue that food was coming.

At first, we problem solved through this by increasing the diet, thinking that they were just really hungry, offering them the first half through the chute so they would "fill" up and calm down, and by selective bridging so as not to reinforce the biting at mesh behavior. The trainers were being very good at feeding in those moments in between the biting and utilizing quick delivery to reinforce not biting while trying to shape their foundation behaviors. Nevertheless, the behavior continued, especially for Trich. When watching a session a couple of weeks into their training, it looked as though the behavior was escalating. It appeared that Trich was biting harder and more frequently because the reinforcement moments in between biting were not enough for her to make the connection that a closed mouth produced the reward. For her, it seemed like she was doing the opposite, thinking the biting was producing the food arrival and so she needed to bite more to make the meat appear. We then came up with a new plan, realizing that to make the connection we needed to take a big step back in order to move forward. We needed to reinforce before she even thought about biting at the mesh.

Conveniently, the placement of our kitchen door to the holding space was now going to help us achieve this new plan. All behaviors were put on hold. Upon first arrival to the cheetah building, one keeper would enter holding space without a pouch or food and open up the lids of the chutes. The diet was rolled into meatballs and put in pouches in the kitchen with the door closed. The kitchen door remained closed until just before the keepers were ready to start training. The door opened, and before the girls could bite, the two trainers bridged and tossed meatballs from just inside the open doorway 8-10 feet into the chutes. They would bridge and toss as long as they weren't biting. If one of them did bite, that trainer walked back into the kitchen area and food stopped during the one minute time out. If the cheetah was doing well with no biting, the trainer might take a step towards the chute and bridge for not biting. We accepted any behavior that had their mouth closed and off the mesh. Trich and Jesiri quickly learned to sit or lay down at the bottom of the chute and wait with mouths closed. After every meatball was dropped they would look at the trainer and wait. Within a week, trainers were walking from the open door to the chutes with much less biting. They were making the connection and we were excited our plan was working.

We transferred this plan to our afternoon training session on exhibit where the mesh is woven wire. The cheetahs weren't as bad at biting the exhibit mesh, but we didn't want mixed messages. We had to devise a chute in order to achieve the same goal. The keepers cut 2.5" diameter PVC about 8" long and then drilled a hole for a clip at one end. The end without the clip is put through the mesh until it reaches halfway. The clip at the top of the other end is clipped higher onto the mesh so the pipe tilts down into the exhibit. Hence, a temporary chute was made for feeding on exhibit.

The next step was to introduce the tongs. We needed the girls to be able to take food from the tongs as our training benches for tail blood draws and ultrasounds are not near the feeding chutes. The trainers started by simply holding the tongs during the training sessions. As the girls continued to be calm with closed mouths, the trainers would slowly bring empty tongs to the mesh and then bridge and reinforce for not biting at the mesh, using the chute to deliver the reinforcement. As they became consistent at that step, we put meat in the tongs and did the same thing. By now, Jesiri was doing really well and Trich was hardly needing a time out for biting anymore. Meat would be in tongs right at the mesh and both of them would simply sit and wait and watch with eyes on the trainer.

We still do about half of the reinforcement during a training session in the form of meatballs down the chute, but we are also able to feed off of tongs as well. While Trich will still bite the meat off the tongs as she eats the reinforcement because she is so eager, they both no longer bite at the mesh while waiting for cues or for the delivery of the reinforcement. In order to set them both up for success, we took an approach that combined stopping the behavior before it started, reinforcing anything other than biting at mesh, and taking a hard line in the form of removal of reinforcement when it did occur. Daily communication was key in ensuring consistency and making sure each trainer was up to speed on criteria. In total, eliminating the mesh biting took the team about three months of consistent work with desensitizing to trainer movement and tong/pouch presence before the team started resuming the shaping of other behaviors. Now Trich and Jesiri are excelling at their training and the team has moved beyond basics to injection, ultrasound and tail behaviors.

Special thanks to the African Carnivore team: Heather Chance, Shayna Kramb, Nathaniel McIntosh, Amanda Ramsay, Kimberly Ashford, and formerly with us Jessica Roldan.

Editor's comments by Kim Kezer

Congratulations to the African Carnivore team for not accepting an undesirable and unwanted behavior before moving ahead with your training program. Sometimes our excitement and eagerness to train clouds our vision and we often allow something like biting on the mesh to happen in the hopes that it will go away. Because of the potential harm to teeth caused by biting on the mesh, recognizing that you needed to stop all other training until this is resolved is important to the overall success of your training program.

There are several approaches to extinguishing a behavior, one of which comes to mind is to get the behavior on cue, ask for the behavior and no longer provide reinforcement, but in this case this would not be in the best interest for the animals' teeth. Utilizing a Least Reinforcing Stimulus (LRS), by reinforcing a calm behavior after the undesirable behavior helps to get the animal to pause for a moment. Those pauses are the moments you want to reinforce. Following the pause, shape if possible, reinforce any incompatible behavior, "a behavior that is impossible to perform at the same time as another specific behavior". In this case, the lie down and sit behaviors are incompatible to biting the mesh.

The placement or change in delivery of the food was helpful in creating a better understanding by the animal. By feeding at the chute, the cheetah did not have any reason to go near the mesh, which means no chances for reinforcing mesh chewing. Another approach to consider is to increase the number of feedings into smaller ones as well as randomizing their feeding schedule and routines. Randomizing the schedule is to ensure that keepers regularly enter those training areas without any food or treats, so that the cats do not automatically associate keeper presence with food. This will help to reduce a predictive routine, as well as decrease psychological hunger and anticipation. The team's success in eliminating this unwanted behavior in three months was facilitated by the daily communication between the trainers.

Well done and thank you for sharing your Training Tale!

We want to hear your Training Tales: the good, the bad and the fabulous!

Did you enjoy the latest Training Tale? Was this information useful or inspiring? Do you have any operant conditioning experiences that others would benefit from reading? Please submit your "Training Tales" and experiences in operant conditioning to share with *Animal Keepers' Forum* readers. This opportunity provides a convenient outlet for you to exhibit your training challenges, methods and milestones with the AAZK member network. Please submit entries based on the following guidelines:

a. Submit a brief description of a training project at your facility. These can be 500 words or less, in text or bullet points – it can be longer (up to 1000 words); however, short and simple descriptions with a few images are just as perfect. Details should include the following:
    1. Define the training goal (what did you try to do and for what purpose?)
    2. List important steps (How did you do it – include plans that changed along the way/what worked and what didn't work)
    3. Timeline used (how long did it take)
    4. Tips you learned along the way

b. Include 3-5 digital photos that clearly depict the animal in the learning process or performing the desired goal (provide photo caption and photographer of each image). Photos need to be 300 dpi and at least 1200 x 1800 pixels.

Please send submissions or questions to:
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Conservation groups, including zoos and local AAZK Chapters have joined together for Year of the Bird. To learn more about how you, your zoo or AAZK Chapter can get involved, go to (https://goo.gl/NU4HAZ) to join the 2018 Year of the Bird movement and pledge your commitment to conserving these beautiful creatures.

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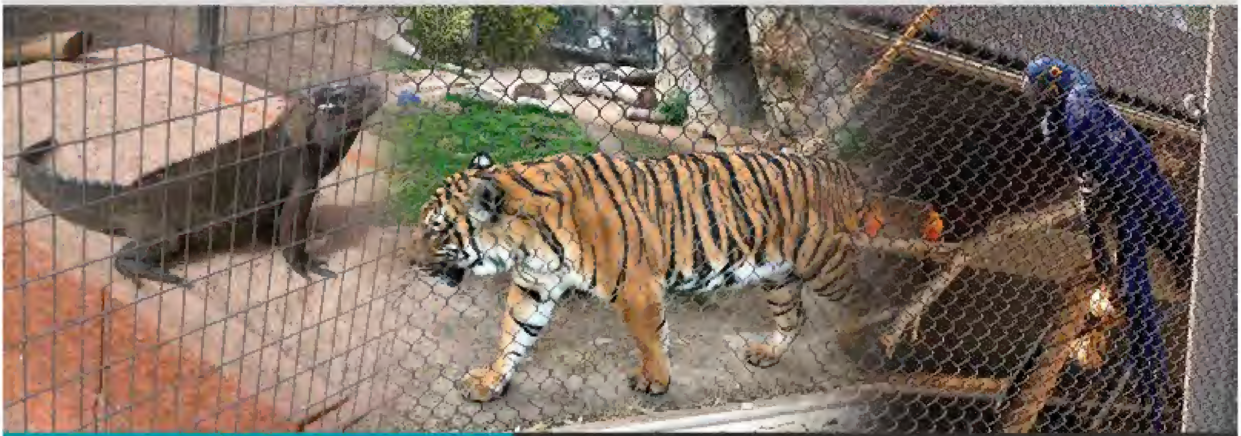

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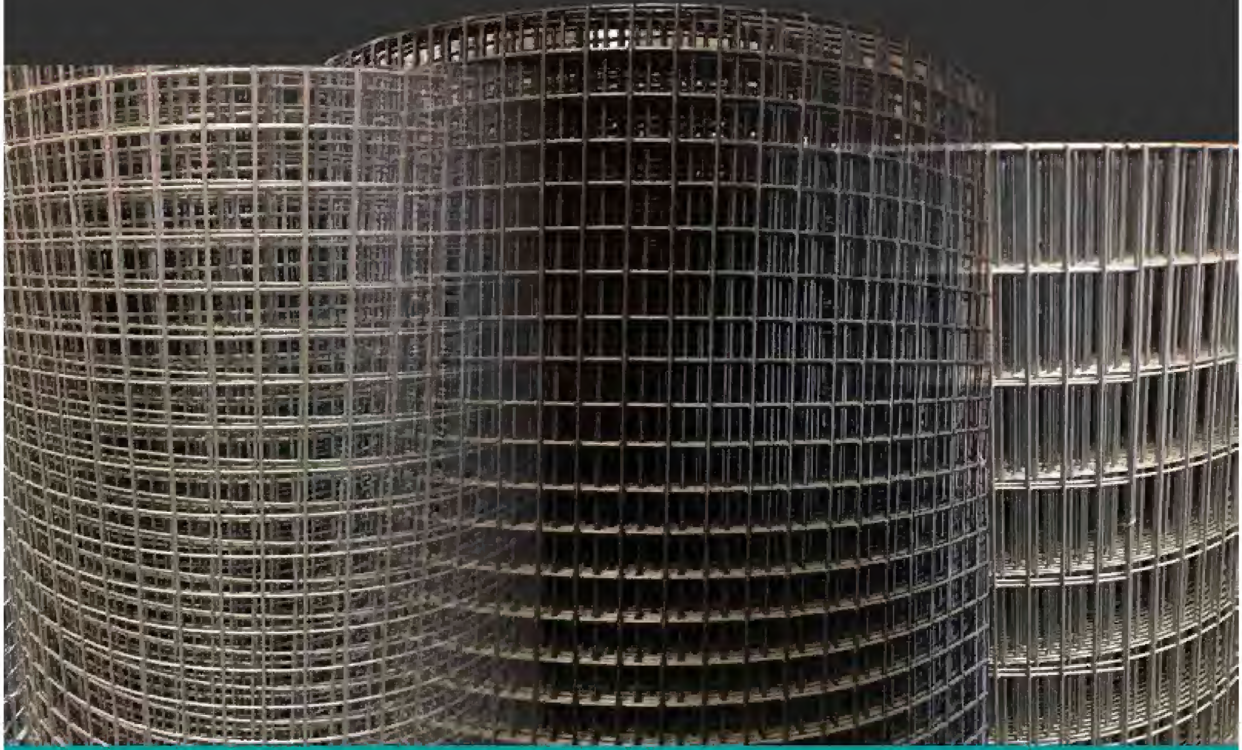

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